

What is claimed is:

1. A method for synthesizing moving images, comprising the steps of:

sampling two consecutive frames from a moving image;

5 providing a reference patch having at least one rectangular region therein, in one of the two frames, which is designated as a reference frame;

providing a second patch, which is the same as the reference patch, in the other of the two frames;

10 moving and/or deforming the second patch in the other of the two frames so that an image within the second patch matches that within the reference image;

estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second  
15 patch after the movement and/or deformation thereof and the reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate  
20 space of the reference frame, based on the correspondent relationships;

calculating a correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

25 varying the number of rectangular regions within the reference patch and the second patch in a stepwise manner,

estimating the aforementioned correspondent relationships,  
obtaining the coordinate converted frames, and calculating the  
correlative values for each number of rectangular regions,  
thereby obtaining a plurality of correlative values  
5 corresponding to the number of rectangular regions within the  
reference patch and the second patch;

comparing the degrees of correlation for each number of  
rectangular regions, based on the plurality of the correlative  
values; and

10 generating a synthesized frame having a higher resolution  
than either of the two frames, by administering interpolation  
calculations on the images within the second patch and the  
reference patch, based on the correspondent relationships,  
which were estimated among the pixels of the reference patch  
15 and the second patch having the number of rectangular regions  
therein that yielded the highest degree of correlation.

2. A method for synthesizing moving images, comprising  
the steps of:

sampling at least three consecutive frames from a moving  
20 image;

providing a reference patch having at least one  
rectangular region therein, in a first frame from among the at  
least three sampled frames, which is designated as a reference  
frame;

25 providing a second patch, which is the same as the  
reference patch, in another of the plurality of sampled frames;

moving and/or deforming the second patch in the other frame so that an image within the second patch matches that within the reference image;

estimating correspondent relationships among the pixels  
5 within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

obtaining a coordinate converted frame, by coordinate  
10 converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

calculating a correlative value, which represents the degree of correlation between the images within the reference  
15 patch of the reference frame and the coordinate converted frame;

varying the number of rectangular regions within the reference patch and the second patch in a stepwise manner, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the  
20 correlative values for each number of rectangular regions, thereby obtaining a plurality of correlative values corresponding to the number of rectangular regions within the reference patch and the second patch;

comparing the degrees of correlation for each number of  
25 rectangular regions, based on the plurality of the correlative values;

obtaining an intermediate synthesized frame having a higher resolution than either the reference frame of the other frame, by administering interpolation calculations on the images within the second patch and the reference patch, based  
5 on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the highest degree of correlation;

obtaining a plurality of intermediate synthesized frames  
10 by estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the plurality of correlative values, and comparing the degrees of correlation for all of the plurality of sampled frames; and  
generating a synthesized frame by synthesizing the  
15 plurality of intermediate synthesized frames.

3. A moving image synthesizing apparatus, comprising:  
a sampling means, for sampling two consecutive frames from a moving image;  
a correspondent relationship estimating means, for:  
20 providing a reference patch having at least one rectangular region therein, in one of the two frames, which is designated as a reference frame; providing a second patch, which is the same as the reference patch, in the other of the two frames;  
moving and/or deforming the second patch in the other of the  
25 two frames so that an image within the second patch matches that within the reference image; and estimating correspondent

relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

5           a coordinate converting means, for obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

          a correlative value calculating means, for calculating  
10   a correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

          a control means, for controlling the correspondent relationship estimating means, the coordinate converting means,  
15   and the correlative value calculating means, to vary the number of rectangular regions within the reference patch and the second patch in a stepwise manner, to estimate the aforementioned correspondent relationships, to obtain the coordinate converted frames, and to calculate the correlative values for  
20   each number of rectangular regions, thereby obtaining a plurality of correlative values corresponding to the number of rectangular regions within the reference patch and the second patch;

          a comparing means, for comparing the degrees of  
25   correlation for each number of rectangular regions, based on the plurality of the correlative values; and

a synthesizing means, for generating a synthesized frame having a higher resolution than either of the two frames, by administering interpolation calculations on the images within the second patch and the reference patch, based on the  
5 correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the highest degree of correlation.

4. A moving image synthesizing apparatus as defined in  
10 claim 3, wherein:

the correspondent relationships employed in the generation of the synthesized frame are those which are estimated for each of the rectangular regions.

5. A moving image synthesizing apparatus as defined in  
15 claim 3, wherein:

the correspondent relationship estimating means, the coordinate converting means, the correlative value calculating means, and the synthesizing means employ at least one component that constitutes the frames during the estimation of the  
20 correspondent relationships, the obtainment of the coordinate converted frames, the calculation of the correlative values, and the generation of the synthesized frame.

6. A moving image synthesizing apparatus, comprising:  
a sampling means, for sampling at least three consecutive  
25 frames from a moving image;

a correspondent relationship estimating means, for:

providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference frame; providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames; moving and/or deforming the second patch in the other frame so that an image within the second patch matches that within the reference image; and estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

a coordinate converting means, for obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

a correlative value calculating means, for calculating a correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

a control means, for controlling the correspondent relationship estimating means, the coordinate converting means, and the correlative value calculating means, to vary the number of rectangular regions within the reference patch and the second patch in a stepwise manner, to estimate the aforementioned correspondent relationships, to obtain the coordinate

converted frames, and to calculate the correlative values for each number of rectangular regions, thereby obtaining a plurality of correlative values corresponding to the number of rectangular regions within the reference patch and the second  
5 patch;

a comparing means, for comparing the degrees of correlation for each number of rectangular regions, based on the plurality of the correlative values; and

a synthesizing means, for: obtaining an intermediate  
10 synthesized frame having a higher resolution than either the reference frame of the other frame, by administering interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of the  
15 reference patch and the second patch having the number of rectangular regions therein that yielded the highest degree of correlation; obtaining a plurality of intermediate synthesized frames by estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames,  
20 calculating the plurality of correlative values, and comparing the correlations for all of the plurality of sampled frames; and generating a synthesized frame by synthesizing the plurality of intermediate synthesized frames.

7. A moving image synthesizing apparatus as defined in  
25 claim 6, wherein:

the correspondent relationships employed in the



generation of the intermediate synthesized frame are those which are estimated for each of the rectangular regions.

8. A moving image synthesizing apparatus as defined in claim 6, wherein:

5       the correspondent relationship estimating means, the coordinate converting means, the correlative value calculating means, and the synthesizing means employ at least one component that constitutes the frames during the estimation of the correspondent relationships, the obtainment of the coordinate  
10 converted frames, the calculation of the correlative values, the generation of the intermediate synthesized frames, and the generation of the synthesized frame.

9. A program that causes a computer to execute a method for synthesizing moving images, comprising the procedures of:

15       sampling two consecutive frames from a moving image;  
      providing a reference patch having at least one rectangular region therein, in one of the two frames, which is designated as a reference frame;

      providing a second patch, which is the same as the  
20 reference patch, in the other of the two frames;

      moving and/or deforming the second patch in the other of the two frames so that an image within the second patch matches that within the reference image;

      estimating correspondent relationships among the pixels  
25 within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second

patch after the movement and/or deformation thereof and the reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

calculating a correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

10       varying the number of rectangular regions within the reference patch and the second patch in a stepwise manner, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the correlative values for each number of rectangular regions, thereby obtaining a plurality of correlative values corresponding to the number of rectangular regions within the reference patch and the second patch;

20       comparing the degrees of correlation for each number of rectangular regions, based on the plurality of the correlative values; and

generating a synthesized frame having a higher resolution than either of the two frames, by administering interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions

therein that yielded the highest degree of correlation.

10. A program that causes a computer to execute a method for synthesizing moving images, comprising the procedures of:

5     sampling at least three consecutive frames from a moving image;

          providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference frame;

10     providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames;

          moving and/or deforming the second patch in the other frame so that an image within the second patch matches that within the reference image;

15     estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

20     obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

          calculating a correlative value, which represents the  
25     degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

varying the number of rectangular regions within the reference patch and the second patch in a stepwise manner, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the  
5 correlative values for each number of rectangular regions, thereby obtaining a plurality of correlative values corresponding to the number of rectangular regions within the reference patch and the second patch;

10 comparing the degrees of correlation for each number of rectangular regions, based on the plurality of the correlative values;

obtaining an intermediate synthesized frame having a higher resolution than either the reference frame of the other frame, by administering interpolation calculations on the  
15 images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the highest degree of correlation;

20 obtaining a plurality of intermediate synthesized frames by estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the plurality of correlative values, and comparing the degrees of correlation for all of the plurality of sampled frames; and  
25 generating a synthesized frame by synthesizing the plurality of intermediate synthesized frames.

11. A method for synthesizing moving images, comprising the steps of:

sampling two consecutive frames from a moving image;

providing a reference patch having at least one  
5 rectangular region therein, in one of the two frames, which is designated as a reference frame;

providing a second patch, which is the same as the reference patch, in the other of the two frames;

moving and/or deforming the second patch in the other of  
10 the two frames so that an image within the second patch matches that within the reference image;

estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second  
15 patch after the movement and/or deformation thereof and the reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent  
20 relationships;

calculating a correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

increasing the number of rectangular regions within the  
25 reference patch and the second patch in a stepwise manner, estimating the aforementioned correspondent relationships,

obtaining the coordinate converted frames, and calculating the  
correlative values for each number of rectangular regions,  
until the degree of correlation is greater than or equal to a  
predetermined threshold value; and

5       generating a synthesized frame having a higher resolution  
than either of the two frames, by administering interpolation  
calculations on the images within the second patch and the  
reference patch, based on the correspondent relationships,  
which were estimated among the pixels of the reference patch  
10   and the second patch having the number of rectangular regions  
therein that yielded the degree of correlation greater than or  
equal to the threshold value.

12. A method for synthesizing moving images, comprising  
the steps of:

15       sampling two consecutive frames from a moving image;  
      providing a reference patch having at least one  
rectangular region therein, in one of the two frames, which is  
designated as a reference frame;

      providing a second patch, which is the same as the  
20   reference patch, in the other of the two frames;

      moving and/or deforming the second patch in the other of  
the two frames so that an image within the second patch matches  
that within the reference image;

      estimating correspondent relationships among the pixels  
25   within the second patch of the other frame and the pixels within  
the reference patch of the reference frame, based on the second

patch after the movement and/or deformation thereof and the reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

calculating correlative values, which represent the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame, for each of the rectangular regions;

increasing the number of rectangular regions within the reference patch and the second patch, in a stepwise manner, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the correlative values for each number of rectangular regions, until the degree of correlation or a representative degree of correlation of all of the rectangular regions, or of the rectangular regions at predetermined positions from among all of the rectangular regions, other than those for which the degree of correlation is less than a predetermined value, or of a predetermined number of rectangular regions from among all of the rectangular regions, other than those for which the degree of correlation is less than a predetermined value, becomes greater than or equal to a predetermined threshold value; and

generating a synthesized frame having a higher resolution

than either of the two frames, by administering interpolation calculations on the images within the second patch and the reference patch for each region corresponding to the rectangular regions, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the degree of correlation or the representative degree of correlation greater than or equal to the threshold value.

10           13. A method for synthesizing moving images, comprising the steps of:

          sampling at least three consecutive frames from a moving image;

          providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference frame;

          providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames;

20           moving and/or deforming the second patch in the other frame so that an image within the second patch matches that within the reference image;

          estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the



reference patch;

obtaining a coordinate converted frame, by coordinate  
converting the image within the second patch into a coordinate  
space of the reference frame, based on the correspondent  
5 relationships;

calculating a correlative value, which represents the  
degree of correlation between the images within the reference  
patch of the reference frame and the coordinate converted frame;

increasing the number of rectangular regions within the  
10 reference patch and the second patch in a stepwise manner,  
estimating the aforementioned correspondent relationships,  
obtaining the coordinate converted frames, and calculating the  
correlative values for each number of rectangular regions,  
until the degree of correlation is greater than or equal to a  
15 predetermined threshold value;

obtaining an intermediate synthesized frame having a  
higher resolution than either the reference frame of the other  
frame, by administering interpolation calculations on the  
images within the second patch and the reference patch for each  
20 region corresponding to the rectangular regions, based on the  
correspondent relationships, which were estimated among the  
pixels of the reference patch and the second patch having the  
number of rectangular regions therein that yielded the degree  
of correlation greater than or equal to the threshold value;

25 obtaining a plurality of intermediate synthesized frames  
by estimating the aforementioned correspondent relationships,

obtaining the coordinate converted frames, and calculating the plurality of correlative values, for all of the plurality of sampled frames; and

generating a synthesized frame by synthesizing the plurality of intermediate synthesized frames.

14. A method for synthesizing moving images, comprising the steps of:

sampling at least three consecutive frames from a moving image;

providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference frame;

providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames;

moving and/or deforming the second patch in the other frame so that an image within the second patch matches that within the reference image;

estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent

relationships;

calculating a correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

5        increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the correlative values for each number of rectangular regions,  
10    until the degree of correlation or a representative degree of correlation of all of the rectangular regions, or of the rectangular regions at predetermined positions from among all of the rectangular regions, other than those for which the degree of correlation is less than a predetermined value, or  
15    of a predetermined number of rectangular regions from among all of the rectangular regions, other than those for which the degree of correlation is less than a predetermined value, becomes greater than or equal to a predetermined threshold value;

20        obtaining an intermediate synthesized frame having a higher resolution than either the reference frame of the other frame, by administering interpolation calculations on the images within the second patch and the reference patch for each region corresponding to the rectangular regions, based on the  
25    correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the

number of rectangular regions therein that yielded the degree of correlation or the representative degree of correlation greater than or equal to the threshold value;

obtaining a plurality of intermediate synthesized frames  
5 by estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the plurality of correlative values, for all of the plurality of sampled frames; and

generating a synthesized frame by synthesizing the  
10 plurality of intermediate synthesized frames.

15. A moving image synthesizing apparatus comprising:

a sampling means, for sampling two consecutive frames from a moving image;

a correspondent relationship estimating means, for:  
15 providing a reference patch having at least one rectangular region therein, in one of the two frames, which is designated as a reference frame; providing a second patch, which is the same as the reference patch, in the other of the two frames; moving and/or deforming the second patch in the other of the  
20 two frames so that an image within the second patch matches that within the reference image; and estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement  
25 and/or deformation thereof and the reference patch;

a coordinate converting means, for obtaining a coordinate

converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

a correlative value calculating means, for calculating  
5 a correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

a control means, for controlling the correspondent relationship estimating means, the coordinate converting means,  
10 and the correlative value calculating means, to increase the number of rectangular regions within the reference patch and the second patch in a stepwise manner, to estimate the aforementioned correspondent relationships, to obtain the coordinate converted frames, and to calculate the correlative  
15 values for each number of rectangular regions, until the degree of correlation is greater than or equal to a predetermined threshold value; and

a synthesizing means, for generating a synthesized frame having a higher resolution than either of the two frames, by  
20 administering interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the degree  
25 of correlation greater than or equal to the predetermined threshold value.

16. A moving image synthesizing apparatus comprising:  
a sampling means, for sampling two consecutive frames  
from a moving image;  
a correspondent relationship estimating means, for:  
5 providing a reference patch having at least one rectangular  
region therein, in one of the two frames, which is designated  
as a reference frame; providing a second patch, which is the  
same as the reference patch, in the other of the two frames;  
moving and/or deforming the second patch in the other of the  
10 two frames so that an image within the second patch matches that  
within the reference image; and estimating correspondent  
relationships among the pixels within the second patch of the  
other frame and the pixels within the reference patch of the  
reference frame, based on the second patch after the movement  
15 and/or deformation thereof and the reference patch;  
a coordinate converting means, for obtaining a coordinate  
converted frame, by coordinate converting the image within the  
second patch into a coordinate space of the reference frame,  
based on the correspondent relationships;  
20 a correlative value calculating means, for calculating  
a correlative value, which represents the degree of correlation  
between the images within the reference patch of the reference  
frame and the coordinate converted frame;  
a control means, for controlling the correspondent  
25 relationship estimating means, the coordinate converting means,  
and the correlative value calculating means, to increase the

number of rectangular regions within the reference patch and the second patch in a stepwise manner, to estimate the aforementioned correspondent relationships, to obtain the coordinate converted frames, and to calculate the correlative values for each number of rectangular regions, until the degree of correlation or a representative degree of correlation of all of the rectangular regions, or of the rectangular regions at predetermined positions from among all of the rectangular regions, other than those for which the degree of correlation is less than a predetermined value, or of a predetermined number of rectangular regions from among all of the rectangular regions, other than those for which the degree of correlation is less than a predetermined value, becomes greater than or equal to a predetermined threshold value; and

a synthesizing means, for generating a synthesized frame having a higher resolution than either of the two frames, by administering interpolation calculations on the images within the second patch and the reference patch for each region corresponding to the rectangular regions, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the degree of correlation or the representative degree of correlation greater than or equal to the predetermined threshold value.

17. A moving image synthesizing apparatus as defined in claim 15, wherein:

the control means decreases the threshold value, according to the increase in the number of rectangular regions, until the number of rectangular regions reaches a predetermined value, and increases the threshold value, when the number of  
5 rectangular regions exceeds the predetermined value.

18. A moving image synthesizing apparatus as defined in claim 16, wherein:

the control means decreases the threshold value, according to the increase in the number of rectangular regions,  
10 until the number of rectangular regions reaches a predetermined value, and increases the threshold value, when the number of rectangular regions exceeds the predetermined value.

19. A moving image synthesizing apparatus as defined in claim 15, wherein:

15 the correspondent relationship estimating means, the coordinate converting means, the correlative value calculating means, and the synthesizing means employ at least one component that constitutes the frames during the estimation of the correspondent relationships, the obtainment of the coordinate  
20 converted frames, the calculation of the correlative values, and the generation of the synthesized frame.

20. A moving image synthesizing apparatus as defined in claim 16, wherein:

the correspondent relationship estimating means, the  
25 coordinate converting means, the correlative value calculating means, and the synthesizing means employ at least one component



that constitutes the frames during the estimation of the correspondent relationships, the obtainment of the coordinate converted frames, the calculation of the correlative values, and the generation of the synthesized frame.

- 5           21. A moving image synthesizing apparatus, comprising:  
          a sampling means, for sampling at least three consecutive frames from a moving image;  
          a correspondent relationship estimating means, for:  
providing a reference patch having at least one rectangular  
10 region therein, in a first frame from among the at least three sampled frames, which is designated as a reference frame;  
providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames; moving  
and/or deforming the second patch in the other frame so that  
15 an image within the second patch matches that within the reference image; and estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation  
20 thereof and the reference patch;  
          a coordinate converting means, for obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;  
25           a correlative value calculating means, for calculating a correlative value, which represents the degree of correlation

between the images within the reference patch of the reference frame and the coordinate converted frame;

a control means, for controlling the correspondent relationship estimating means, the coordinate converting means, and the correlative value calculating means, to increase the number of rectangular regions within the reference patch and the second patch in a stepwise manner, to estimate the aforementioned correspondent relationships, to obtain the coordinate converted frames, and to calculate the correlative values for each number of rectangular regions, until the degree of correlation is greater than or equal to a predetermined threshold value; and

a synthesizing means, for: obtaining an intermediate synthesized frame having a higher resolution than either the reference frame of the other frame, by: administering interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the degree of correlation greater than or equal to the threshold value; obtaining a plurality of intermediate synthesized frames by estimating the aforementioned correspondent relationships obtaining the coordinate converted frames, and calculating the plurality of correlative values, for all of the plurality of sampled frames; and generating a synthesized frame by

synthesizing the plurality of intermediate synthesized frames.

22. A moving image synthesizing apparatus, comprising:

a sampling means, for sampling at least three consecutive frames from a moving image;

5        a correspondent relationship estimating means, for:  
providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference frame;  
providing a second patch, which is the same as the reference  
10 patch, in another of the plurality of sampled frames; moving  
and/or deforming the second patch in the other frame so that an image within the second patch matches that within the reference image; and estimating correspondent relationships  
among the pixels within the second patch of the other frame and  
15 the pixels within the reference patch of the reference frame,  
based on the second patch after the movement and/or deformation thereof and the reference patch;

a coordinate converting means, for obtaining a coordinate converted frame, by coordinate converting the image within the  
20 second patch into a coordinate space of the reference frame,  
based on the correspondent relationships;

a correlative value calculating means, for calculating a correlative value, which represents the degree of correlation between the images within the reference patch of the reference  
25 frame and the coordinate converted frame;

a control means, for controlling the correspondent

relationship estimating means, the coordinate converting means,  
and the correlative value calculating means, to increase the  
number of rectangular regions within the reference patch and  
the second patch in a stepwise manner, to estimate the  
5   aforementioned correspondent relationships, to obtain the  
coordinate converted frames, and to calculate the correlative  
values for each number of rectangular regions, until the degree  
of correlation or a representative degree of correlation of all  
of the rectangular regions, or of the rectangular regions at  
10   predetermined positions from among all of the rectangular  
regions, other than those for which the degree of correlation  
is less than a predetermined value, or of a predetermined number  
of rectangular regions from among all of the rectangular regions,  
other than those for which the degree of correlation is less  
15   than a predetermined value, becomes greater than or equal to  
a predetermined threshold value; and

        a synthesizing means, for: obtaining an intermediate  
synthesized frame having a higher resolution than either the  
reference frame of the other frame, by: administering  
20   interpolation calculations on the images within the second  
patch and the reference patch for each region corresponding to  
the rectangular regions, based on the correspondent  
relationships, which were estimated among the pixels of the  
reference patch and the second patch having the number of  
25   rectangular regions therein that yielded the degree of  
correlation or the representative degree of correlation greater

than or equal to the threshold value; obtaining a plurality of intermediate synthesized frames by estimating the aforementioned correspondent relationships obtaining the coordinate converted frames, and calculating the plurality of  
5 correlative values, for all of the plurality of sampled frames; and generating a synthesized frame by synthesizing the plurality of intermediate synthesized frames.

23. A moving image synthesizing apparatus as defined in claim 21, wherein:

10 the control means decreases the threshold value, according to the increase in the number of rectangular regions, until the number of rectangular regions reaches a predetermined value, and increases the threshold value, according to the increase in the number of rectangular regions, when the number  
15 of rectangular regions exceeds the predetermined value.

24. A moving image synthesizing apparatus as defined in claim 22, wherein:

the control means decreases the threshold value, according to the increase in the number of rectangular regions, until the number of rectangular regions reaches a predetermined  
20 value, and increases the threshold value, according to the increase in the number of rectangular regions, when the number of rectangular regions exceeds the predetermined value.

25. A moving image synthesizing apparatus as defined in  
25 claim 21, wherein:

the correspondent relationship estimating means, the

coordinate converting means, the correlative value calculating means, and the synthesizing means employ at least one component that constitutes the frames during the estimation of the correspondent relationships, the obtainment of the coordinate converted frames, the calculation of the correlative values, the generation of the intermediate synthesized frames, and the generation of the synthesized frame.

26. A moving image synthesizing apparatus as defined in claim 22, wherein:

the correspondent relationship estimating means, the coordinate converting means, the correlative value calculating means, and the synthesizing means employ at least one component that constitutes the frames during the estimation of the correspondent relationships, the obtainment of the coordinate converted frames, the calculation of the correlative values, the generation of the intermediate synthesized frames, and the generation of the synthesized frame.

27. A program that causes a computer to execute a method for synthesizing moving images, comprising the procedures of:

sampling two consecutive frames from a moving image; providing a reference patch having at least one rectangular region therein, in one of the two frames, which is designated as a reference frame;

providing a second patch, which is the same as the reference patch, in the other of the two frames;

moving and/or deforming the second patch in the other of

the two frames so that an image within the second patch matches that within the reference image;

estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

calculating a correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the correlative values for each number of rectangular regions, until the degree of correlation is greater than or equal to a predetermined threshold value; and

generating a synthesized frame having a higher resolution than either of the two frames, by administering interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships,

which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the degree of correlation greater than or equal to the threshold value.

- 5        28. A program that causes a computer to execute a method for synthesizing moving images, comprising the procedures of:
- sampling two consecutive frames from a moving image;
  - providing a reference patch having at least one rectangular region therein, in one of the two frames, which is  
10 designated as a reference frame;
  - providing a second patch, which is the same as the reference patch, in the other of the two frames;
  - moving and/or deforming the second patch in the other of the two frames so that an image within the second patch matches  
15 that within the reference image;
  - estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the  
20 reference patch;
  - obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;
  - 25 calculating correlative values, which represent the degree of correlation between the images within the reference



patch of the reference frame and the coordinate converted frame,  
for each of the rectangular regions;

increasing the number of rectangular regions within the  
reference patch and the second patch, in a stepwise manner,  
5 estimating the aforementioned correspondent relationships,  
obtaining the coordinate converted frames, and calculating the  
correlative values for each number of rectangular regions,  
until the degree of correlation or a representative degree of  
correlation of all of the rectangular regions, or of the  
10 rectangular regions at predetermined positions from among all  
of the rectangular regions, other than those for which the  
degree of correlation is less than a predetermined value, or  
of a predetermined number of rectangular regions from among all  
of the rectangular regions, other than those for which the  
15 degree of correlation is less than a predetermined value,  
becomes greater than or equal to a predetermined threshold  
value; and

generating a synthesized frame having a higher resolution  
than either of the two frames, by administering interpolation  
20 calculations on the images within the second patch and the  
reference patch for each region corresponding to the  
rectangular regions, based on the correspondent relationships,  
which were estimated among the pixels of the reference patch  
and the second patch having the number of rectangular regions  
25 therein that yielded the degree of correlation or the  
representative degree of correlation greater than or equal to

the threshold value.

29. A program that causes a computer to execute a method for synthesizing moving images, comprising the procedures of:

5     sampling at least three consecutive frames from a moving image;

          providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference frame;

10     providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames;

          moving and/or deforming the second patch in the other frame so that an image within the second patch matches that within the reference image;

15     estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

20     obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

          calculating a correlative value, which represents the  
25     degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the  
5 correlative values for each number of rectangular regions, until the degree of correlation is greater than or equal to a predetermined threshold value;

obtaining an intermediate synthesized frame having a higher resolution than either the reference frame of the other  
10 frame, by administering interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the  
15 degree of correlation greater than or equal to the threshold value;

obtaining a plurality of intermediate synthesized frames by estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the  
20 plurality of correlative values, for all of the plurality of sampled frames; and

generating a synthesized frame by synthesizing the plurality of intermediate synthesized frames.

30. A program that causes a computer to execute a method  
25 for synthesizing moving images, comprising the procedures of:  
sampling at least three consecutive frames from a moving

image;

providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference  
5 frame;

providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames;

moving and/or deforming the second patch in the other frame so that an image within the second patch matches that  
10 within the reference image;

estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the  
15 reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

20 calculating a correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

increasing the number of rectangular regions within the  
25 reference patch and the second patch in a stepwise manner, estimating the aforementioned correspondent relationships,

obtaining the coordinate converted frames, and calculating the  
correlative values for each number of rectangular regions,  
until the degree of correlation or a representative degree of  
correlation of all of the rectangular regions, or of the  
5 rectangular regions at predetermined positions from among all  
of the rectangular regions, other than those for which the  
degree of correlation is less than a predetermined value, or  
of a predetermined number of rectangular regions from among all  
of the rectangular regions, other than those for which the  
10 degree of correlation is less than a predetermined value,  
becomes greater than or equal to a predetermined threshold  
value;

obtaining an intermediate synthesized frame having a  
higher resolution than either the reference frame of the other  
15 frame, by administering interpolation calculations on the  
images within the second patch and the reference patch for each  
region corresponding to the rectangular regions, based on the  
correspondent relationships, which were estimated among the  
pixels of the reference patch and the second patch having the  
20 number of rectangular regions therein that yielded the degree  
of correlation or the representative degree of correlation  
greater than or equal to the threshold value;

obtaining a plurality of intermediate synthesized frames  
by estimating the aforementioned correspondent relationships,  
25 obtaining the coordinate converted frames, and calculating the  
plurality of correlative values, for all of the plurality of

sampled frames; and

generating a synthesized frame by synthesizing the plurality of intermediate synthesized frames.

31. A method for synthesizing moving images, comprising  
5 the steps of:

sampling two consecutive frames from a moving image;

providing a reference patch having at least one rectangular region therein, in one of the two frames, which is designated as a reference frame;

10 providing a second patch, which is the same as the reference patch, in the other of the two frames;

moving and/or deforming the second patch in the other of the two frames so that an image within the second patch matches that within the reference image;

15 estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

20 obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

calculating a first correlative value, which represents  
25 the degree of correlation between the images within the reference patch of the reference frame and the coordinate

converted frame;

increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner by one step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and  
5 calculating the correlative value, thereby obtaining a second correlative value;

calculating the variation between the first and second correlative values;

10 increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner an additional step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the first and second correlative values, and  
15 calculating the variation between the first and second correlative values of consecutive steps, until the variation becomes less than or equal to a predetermined threshold value;  
and

generating a synthesized frame having a higher resolution  
20 than either of the two frames, by administering interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of either of the reference patches and the second patches having the number of rectangular  
25 regions therein that yielded the variation less than or equal to the threshold value.

32. A method for synthesizing moving images, comprising the steps of:

sampling two consecutive frames from a moving image;

providing a reference patch having at least one  
5 rectangular region therein, in one of the two frames, which is designated as a reference frame;

providing a second patch, which is the same as the reference patch, in the other of the two frames;

moving and/or deforming the second patch in the other of  
10 the two frames so that an image within the second patch matches that within the reference image;

estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second  
15 patch after the movement and/or deformation thereof and the reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent  
20 relationships;

calculating a first correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame, for each of the rectangular regions;

25 increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner by



one step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the correlative value, thereby obtaining a second correlative value;

5       calculating the variation between the first and second correlative values for each of the rectangular regions;

          increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner an additional step, estimating the aforementioned correspondent  
10 relationships, obtaining the coordinate converted frames, calculating the first and second correlative values, and calculating the variation between the first and second correlative values of consecutive steps, until the variation or a representative variation of all of the rectangular regions,  
15 or of the rectangular regions at predetermined positions from among all of the rectangular regions, other than those for which the variation is greater than or equal to a predetermined value, or of a predetermined number of rectangular regions from among all of the rectangular regions, other than those for which the  
20 variation is greater than or equal to a predetermined value, becomes less than or equal to a predetermined threshold value; and

          generating a synthesized frame having a higher resolution than either of the two frames, by administering interpolation  
25 calculations on the images within the second patch and the reference patch for each region corresponding to the

rectangular regions, based on the correspondent relationships, which were estimated among the pixels of either of the reference patches and the second patches having the number of rectangular regions therein that yielded the variation or the  
5 representative variation less than or equal to the threshold value.

33. A method for synthesizing moving images, comprising the steps of:

sampling at least three consecutive frames from a moving  
10 image;

providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference frame;

15 providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames;

moving and/or deforming the second patch in the other frame so that an image within the second patch matches that within the reference image;

20 estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

25 obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate

space of the reference frame, based on the correspondent relationships;

calculating a first correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner by one step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the correlative value, thereby obtaining a second correlative value;

calculating the variation between the first and second correlative values;

increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner an additional step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the first and second correlative values, and calculating the variation between the first and second correlative values of consecutive steps, until the variation becomes less than or equal to a predetermined threshold value;

obtaining an intermediate synthesized frame having a higher resolution than either the reference frame of the other frame, by administering interpolation calculations on the images within the second patch and the reference patch, based

on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the variation less than or equal to the threshold value;

5        obtaining a plurality of intermediate synthesized frames by estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the plurality of correlative values, and calculating the variations among the plurality of the correlative values, for all of the  
10       plurality of sampled frames; and

             generating a synthesized frame by synthesizing the plurality of intermediate synthesized frames.

34. A method for synthesizing moving images, comprising the steps of:

15        sampling at least three consecutive frames from a moving image;

             providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference  
20       frame;

             providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames;

             moving and/or deforming the second patch in the other frame so that an image within the second patch matches that  
25       within the reference image;

             estimating correspondent relationships among the pixels

within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

5           obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

          calculating a first correlative value, which represents  
10   the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame, for each of the rectangular regions;

          increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner by  
15   one step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the correlative value, thereby obtaining a second correlative value;

          calculating the variation between the first and second  
20   correlative values for each of the rectangular regions;

          increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner an additional step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames,  
25   calculating the first and second correlative values, and calculating the variation between the first and second

correlative values of consecutive steps, until the variation or a representative variation of all of the rectangular regions, or of the rectangular regions at predetermined positions from among all of the rectangular regions, other than those for which the variation is greater than or equal to a predetermined value, or of a predetermined number of rectangular regions from among all of the rectangular regions, other than those for which the variation is greater than or equal to a predetermined value, becomes less than or equal to a predetermined threshold value;

obtaining an intermediate synthesized frame having a higher resolution than either the reference frame of the other frame, by administering interpolation calculations on the images within the second patch and the reference patch for each region corresponding to the rectangular regions, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the variation or the representative variation less than or equal to the threshold value;

obtaining a plurality of intermediate synthesized frames by estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the plurality of correlative values, and calculating the variations among the plurality of the correlative values, for all of the plurality of sampled frames; and

generating a synthesized frame by synthesizing the

plurality of intermediate synthesized frames.

35. A moving image synthesizing apparatus, comprising:

a sampling means, for sampling two consecutive frames from a moving image;

5        a correspondent relationship estimating means, for:  
providing a reference patch having at least one rectangular region therein, in one of the two frames, which is designated as a reference frame; providing a second patch, which is the same as the reference patch, in the other of the two frames;  
10    moving and/or deforming the second patch in the other of the two frames so that an image within the second patch matches that within the reference image; and estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the  
15    reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

a coordinate converting means, for obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame,  
20    based on the correspondent relationships;

a correlative value calculating means, for calculating a first correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

25        a control means, for controlling the correspondent relationship estimating means, the coordinate converting means,

and the correlative value calculating means, to increase the number of rectangular regions within the reference patch and the second patch in a stepwise manner by one step, to estimate the aforementioned correspondent relationships, to obtain the coordinate converted frames, and to calculate the correlative value, thereby obtaining a second correlative value;

a variation calculating means, for calculating the variation between the first and second correlative values;

a comparing means, for controlling the correspondent relationship estimating means, the coordinate converting means, the correlative relationship calculating means, and the variation calculating means, to increase the number of rectangular regions within the reference patch and the second patch in a stepwise manner an additional step, to estimate the aforementioned correspondent relationships, to obtain the coordinate converted frames, to calculate the first and second correlative values, and to calculate the variation between the first and second correlative values of consecutive steps, until the variation becomes less than or equal to a predetermined threshold value; and

a synthesizing means, for generating a synthesized frame having a higher resolution than either of the two frames, by administering interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of either of the reference patches and the second patches



having the number of rectangular regions therein that yielded the variation less than or equal to the threshold value.

36. A moving image synthesizing apparatus, comprising:

a sampling means, for sampling two consecutive frames  
5 from a moving image;

a correspondent relationship estimating means, for:  
providing a reference patch having at least one rectangular  
region therein, in one of the two frames, which is designated  
as a reference frame; providing a second patch, which is the  
10 same as the reference patch, in the other of the two frames;  
moving and/or deforming the second patch in the other of the  
two frames so that an image within the second patch matches that  
within the reference image; and estimating correspondent  
relationships among the pixels within the second patch of the  
15 other frame and the pixels within the reference patch of the  
reference frame, based on the second patch after the movement  
and/or deformation thereof and the reference patch;

a coordinate converting means, for obtaining a coordinate  
converted frame, by coordinate converting the image within the  
20 second patch into a coordinate space of the reference frame,  
based on the correspondent relationships;

a correlative value calculating means, for calculating  
a first correlative value, which represents the degree of  
correlation between the images within the reference patch of  
25 the reference frame and the coordinate converted frame, for each  
of the rectangular regions;

a control means, for controlling the correspondent relationship estimating means, the coordinate converting means, and the correlative value calculating means, to increase the number of rectangular regions within the reference patch and the second patch in a stepwise manner by one step, to estimate the aforementioned correspondent relationships, to obtain the coordinate converted frames, and to calculate the correlative value, thereby obtaining a second correlative value;

a variation calculating means, for calculating the variation between the first and second correlative values for each of the rectangular regions;

a comparing means, for controlling the correspondent relationship estimating means, the coordinate converting means, the correlative relationship calculating means, and the variation calculating means, to increase the number of rectangular regions within the reference patch and the second patch in a stepwise manner an additional step, to estimate the aforementioned correspondent relationships, to obtain the coordinate converted frames, to calculate the first and second correlative values, and to calculate the variation between the first and second correlative values of consecutive steps, until the variation or a representative variation of all of the rectangular regions, or of the rectangular regions at predetermined positions from among all of the rectangular regions, other than those for which the variation is greater than or equal to a predetermined value, or of a predetermined

number of rectangular regions from among all of the rectangular regions, other than those for which the variation is greater than or equal to a predetermined value, becomes less than or equal to a predetermined threshold value; and

5           a synthesizing means, for generating a synthesized frame having a higher resolution than either of the two frames, by administering interpolation calculations on the images within the second patch and the reference patch for each region corresponding to the rectangular regions, based on the  
10 correspondent relationships, which were estimated among the pixels of either of the reference patches and the second patches having the number of rectangular regions therein that yielded the variation or the representative variation less than or equal to the threshold value.

15           37. A moving image synthesizing apparatus as defined in claim 35, wherein:

          the control means sets the predetermined threshold value to be larger, according to the increase in the number of rectangular regions, when the number of rectangular regions  
20 exceeds a predetermined value.

          38. A moving image synthesizing apparatus as defined in claim 36, wherein:

          the control means sets the predetermined threshold value to be larger, according to the increase in the number of  
25 rectangular regions, when the number of rectangular regions exceeds a predetermined value.

39. A moving image synthesizing apparatus as defined in claim 35, wherein:

the correspondent relationship estimating means, the coordinate converting means, the correlative value calculating means, the control means, the variation calculating means, the comparing means, and the synthesizing means employ at least one component that constitutes the frames during the estimation of the correspondent relationships, the obtainment of the coordinate converted frames, the calculation of the correlative values, the calculation of the variations, and the generation of the synthesized frame.

40. A moving image synthesizing apparatus as defined in claim 36, wherein:

the correspondent relationship estimating means, the coordinate converting means, the correlative value calculating means, the control means, the variation calculating means, the comparing means, and the synthesizing means employ at least one component that constitutes the frames during the estimation of the correspondent relationships, the obtainment of the coordinate converted frames, the calculation of the correlative values, the calculation of the variations, and the generation of the synthesized frame.

41. A moving image synthesizing apparatus, comprising:  
a sampling means, for sampling at least three consecutive frames from a moving image;

a correspondent relationship estimating means, for:

providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference frame; providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames; moving and/or deforming the second patch in the other frame so that an image within the second patch matches that within the reference image; and estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

a coordinate converting means, for obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

a correlative value calculating means, for calculating a first correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

a control means, for controlling the correspondent relationship estimating means, the coordinate converting means, and the correlative value calculating means, to increase the number of rectangular regions within the reference patch and the second patch in a stepwise manner by one step, to estimate the aforementioned correspondent relationships, to obtain the

coordinate converted frames, and to calculate the correlative value, thereby obtaining a second correlative value;

a variation calculating means, for calculating the variation between the first and second correlative values;

5 a comparing means, for controlling the correspondent relationship estimating means, the coordinate converting means, the correlative value calculating means, and the variation calculating means, to increase the number of rectangular regions within the reference patch and the second patch in a  
10 stepwise manner an additional step, to estimate the aforementioned correspondent relationships, to obtain the coordinate converted frames, to calculate the first and second correlative values, and to calculate the variation between the first and second correlative values of consecutive steps, until  
15 the variation becomes less than or equal to a predetermined threshold value; and

a synthesizing means, for: obtaining an intermediate synthesized frame having a higher resolution than either the reference frame of the other frame, by administering  
20 interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the variation less  
25 than or equal to the threshold value; obtaining a plurality of intermediate synthesized frames by estimating the

aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the plurality of correlative values, and calculating the variations among the plurality of the correlative values, for all of the plurality of sampled frames; and generating a synthesized frame by synthesizing the plurality of intermediate synthesized frames.

42. A moving image synthesizing apparatus, comprising:

a sampling means, for sampling at least three consecutive frames from a moving image;

10 a correspondent relationship estimating means, for: providing a reference patch having at least one rectangular region therein, in a first frame from among the at least three sampled frames, which is designated as a reference frame; providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames; moving.  
15 and/or deforming the second patch in the other frame so that an image within the second patch matches that within the reference image; and estimating correspondent relationships among the pixels within the second patch of the other frame and  
20 the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

a coordinate converting means, for obtaining a coordinate converted frame, by coordinate converting the image within the  
25 second patch into a coordinate space of the reference frame, based on the correspondent relationships;

a correlative value calculating means, for calculating  
a first correlative value, which represents the degree of  
correlation between the images within the reference patch of  
the reference frame and the coordinate converted frame, for each  
5 of the rectangular regions;

a control means, for controlling the correspondent  
relationship estimating means, the coordinate converting means,  
and the correlative value calculating means, to increase the  
number of rectangular regions within the reference patch and  
10 the second patch in a stepwise manner by one step, to estimate  
the aforementioned correspondent relationships, to obtain the  
coordinate converted frames, and to calculate the correlative  
value, thereby obtaining a second correlative value;

a variation calculating means, for calculating the  
15 variation between the first and second correlative values for  
each of the rectangular regions;

a comparing means, for controlling the correspondent  
relationship estimating means, the coordinate converting means,  
the correlative value calculating means, and the variation  
20 calculating means, to increase the number of rectangular  
regions within the reference patch and the second patch in a  
stepwise manner an additional step, to estimate the  
aforementioned correspondent relationships, to obtain the  
coordinate converted frames, to calculate the first and second  
25 correlative values, and to calculate the variation between the  
first and second correlative values of consecutive steps, until



the variation of all of the rectangular regions, or of the rectangular regions at predetermined positions from among all of the rectangular regions, other than those for which the variation is greater than or equal to a predetermined value, or of a predetermined number of rectangular regions from among all of the rectangular regions, other than those for which the variation is greater than or equal to a predetermined value, becomes less than or equal to a predetermined threshold value; and

10 a synthesizing means, for: obtaining an intermediate synthesized frame having a higher resolution than either the reference frame of the other frame, by administering interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the variation or the representative variation less than or equal to the threshold value; obtaining a plurality of intermediate synthesized frames  
15 by estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the plurality of correlative values, and calculating the variations among the plurality of the correlative values, for all of the plurality of sampled frames; and generating a synthesized frame  
20 by synthesizing the plurality of intermediate synthesized frames.  
25

43. A moving image synthesizing apparatus as defined in claim 41, wherein:

the control means sets the predetermined threshold value to be larger, according to the increase in the number of rectangular regions, when the number of rectangular regions exceeds a predetermined value.

44. A moving image synthesizing apparatus as defined in claim 42, wherein:

the control means sets the predetermined threshold value to be larger, according to the increase in the number of rectangular regions, when the number of rectangular regions exceeds a predetermined value.

45. A moving image synthesizing apparatus as defined in claim 41, wherein:

the correspondent relationship estimating means, the coordinate converting means, the correlative value calculating means, the control means, the variation calculating means, the comparing means, and the synthesizing means employ at least one component that constitutes the frames during the estimation of the correspondent relationships, the obtainment of the coordinate converted frames, the calculation of the correlative values, the calculation of the variations, the generation of the intermediate synthesized frames, and the generation of the synthesized frame.

46. A moving image synthesizing apparatus as defined in claim 42, wherein:

the correspondent relationship estimating means, the coordinate converting means, the correlative value calculating means, the control means, the variation calculating means, the comparing means, and the synthesizing means employ at least one  
5 component that constitutes the frames during the estimation of the correspondent relationships, the obtainment of the coordinate converted frames, the calculation of the correlative values, the calculation of the variations, the generation of the intermediate synthesized frames, and the generation of the  
10 synthesized frame.

47. A program that causes a computer to execute a method for synthesizing moving images, comprising the procedures of:  
sampling two consecutive frames from a moving image;  
providing a reference patch having at least one  
15 rectangular region therein, in one of the two frames, which is designated as a reference frame;  
providing a second patch, which is the same as the reference patch, in the other of the two frames;  
moving and/or deforming the second patch in the other of  
20 the two frames so that an image within the second patch matches that within the reference image;  
estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second  
25 patch after the movement and/or deformation thereof and the reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

5       calculating a first correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

10       increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner by one step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the correlative value, thereby obtaining a second correlative value;

15       calculating the variation between the first and second correlative values;

20       increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner an additional step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the first and second correlative values, and calculating the variation between the first and second correlative values of consecutive steps, until the variation becomes less than or equal to a predetermined threshold value;

25       and

generating a synthesized frame having a higher resolution

than either of the two frames, by administering interpolation calculations on the images within the second patch and the reference patch, based on the correspondent relationships, which were estimated among the pixels of either of the reference patches and the second patches having the number of rectangular regions therein that yielded the variation less than or equal to the threshold value.

48. A program that causes a computer to execute a method for synthesizing moving images, comprising the procedures of:

10        sampling two consecutive frames from a moving image;  
         providing a reference patch having at least one rectangular region therein, in one of the two frames, which is designated as a reference frame;

15        providing a second patch, which is the same as the reference patch, in the other of the two frames;

         moving and/or deforming the second patch in the other of the two frames so that an image within the second patch matches that within the reference image;

20        estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the reference patch;

25        obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent

relationships;

calculating a first correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate  
5 converted frame, for each of the rectangular regions;

increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner by one step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and  
10 calculating the correlative value, thereby obtaining a second correlative value;

calculating the variation between the first and second correlative values for each of the rectangular regions;

increasing the number of rectangular regions within the  
15 reference patch and the second patch in a stepwise manner an additional step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the first and second correlative values, and calculating the variation between the first and second  
20 correlative values of consecutive steps, until the variation or a representative variation of all of the rectangular regions, or of the rectangular regions at predetermined positions from among all of the rectangular regions, other than those for which the variation is greater than or equal to a predetermined value,  
25 or of a predetermined number of rectangular regions from among all of the rectangular regions, other than those for which the

variation is greater than or equal to a predetermined value,  
becomes less than or equal to a predetermined threshold value;  
and

generating a synthesized frame having a higher resolution  
5 than either of the two frames, by administering interpolation  
calculations on the images within the second patch and the  
reference patch for each region corresponding to the  
rectangular regions, based on the correspondent relationships,  
which were estimated among the pixels of either of the reference  
10 patches and the second patches having the number of rectangular  
regions therein that yielded the variation or the  
representative variation less than or equal to the threshold  
value.

49. A program that causes a computer to execute a method  
15 for synthesizing moving images, comprising the procedures of:

sampling at least three consecutive frames from a moving  
image;

providing a reference patch having at least one  
rectangular region therein, in a first frame from among the at  
20 least three sampled frames, which is designated as a reference  
frame;

providing a second patch, which is the same as the  
reference patch, in another of the plurality of sampled frames;

moving and/or deforming the second patch in the other  
25 frame so that an image within the second patch matches that  
within the reference image; z

estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second patch after the movement and/or deformation thereof and the  
5 reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent relationships;

10 calculating a first correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame;

increasing the number of rectangular regions within the  
15 reference patch and the second patch in a stepwise manner by one step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the correlative value, thereby obtaining a second correlative value;

20 calculating the variation between the first and second correlative values;

increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner an additional step, estimating the aforementioned correspondent  
25 relationships, obtaining the coordinate converted frames, calculating the first and second correlative values, and



calculating the variation between the first and second  
correlative values of consecutive steps, until the variation  
becomes less than or equal to a predetermined threshold value;

obtaining an intermediate synthesized frame having a  
5 higher resolution than either the reference frame of the other  
frame, by administering interpolation calculations on the  
images within the second patch and the reference patch, based  
on the correspondent relationships, which were estimated among  
the pixels of the reference patch and the second patch having  
10 the number of rectangular regions therein that yielded the  
variation less than or equal to the threshold value;

obtaining a plurality of intermediate synthesized frames  
by estimating the aforementioned correspondent relationships,  
obtaining the coordinate converted frames, calculating the  
15 plurality of correlative values, and calculating the variations  
among the plurality of the correlative values, for all of the  
plurality of sampled frames; and

generating a synthesized frame by synthesizing the  
plurality of intermediate synthesized frames.

20 50. A program that causes a computer to execute a method  
for synthesizing moving images, comprising the procedures of:

sampling at least three consecutive frames from a moving  
image;

providing a reference patch having at least one  
25 rectangular region therein, in a first frame from among the at  
least three sampled frames, which is designated as a reference

frame;

providing a second patch, which is the same as the reference patch, in another of the plurality of sampled frames;

moving and/or deforming the second patch in the other  
5 frame so that an image within the second patch matches that within the reference image;

estimating correspondent relationships among the pixels within the second patch of the other frame and the pixels within the reference patch of the reference frame, based on the second  
10 patch after the movement and/or deformation thereof and the reference patch;

obtaining a coordinate converted frame, by coordinate converting the image within the second patch into a coordinate space of the reference frame, based on the correspondent  
15 relationships;

calculating a first correlative value, which represents the degree of correlation between the images within the reference patch of the reference frame and the coordinate converted frame, for each of the rectangular regions;

20 increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner by one step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, and calculating the correlative value, thereby obtaining a second  
25 correlative value;

calculating the variation between the first and second

correlative values for each of the rectangular regions;

increasing the number of rectangular regions within the reference patch and the second patch in a stepwise manner an additional step, estimating the aforementioned correspondent relationships, obtaining the coordinate converted frames, calculating the first and second correlative values, and calculating the variation between the first and second correlative values of consecutive steps, until the variation or a representative variation of all of the rectangular regions, or of the rectangular regions at predetermined positions from among all of the rectangular regions, other than those for which the variation is greater than or equal to a predetermined value, or of a predetermined number of rectangular regions from among all of the rectangular regions, other than those for which the variation is greater than or equal to a predetermined value, becomes less than or equal to a predetermined threshold value;

obtaining an intermediate synthesized frame having a higher resolution than either the reference frame of the other frame, by administering interpolation calculations on the images within the second patch and the reference patch for each region corresponding to the rectangular regions, based on the correspondent relationships, which were estimated among the pixels of the reference patch and the second patch having the number of rectangular regions therein that yielded the variation or the representative variation less than or equal to the threshold value;

obtaining a plurality of intermediate synthesized frames  
by estimating the aforementioned correspondent relationships,  
obtaining the coordinate converted frames, calculating the  
plurality of correlative values, and calculating the variations  
5 among the plurality of the correlative values, for all of the  
plurality of sampled frames; and

generating a synthesized frame by synthesizing the  
plurality of intermediate synthesized frames:

51. A computer readable medium having recorded therein  
10 the program defined in claim 9.

52. A computer readable medium having recorded therein  
the program defined in claim 10.

53. A computer readable medium having recorded therein  
the program defined in claim 27.

15 54. A computer readable medium having recorded therein  
the program defined in claim 28.

55. A computer readable medium having recorded therein  
the program defined in claim 29.

20 56. A computer readable medium having recorded therein  
the program defined in claim 30.

57. A computer readable medium having recorded therein  
the program defined in claim 47.

58. A computer readable medium having recorded therein  
the program defined in claim 48.

25 59. A computer readable medium having recorded therein  
the program defined in claim 49.

60. A computer readable medium having recorded therein the program defined in claim 50.